

Impact of the cathode supporting structure and PMT configuration on light signal

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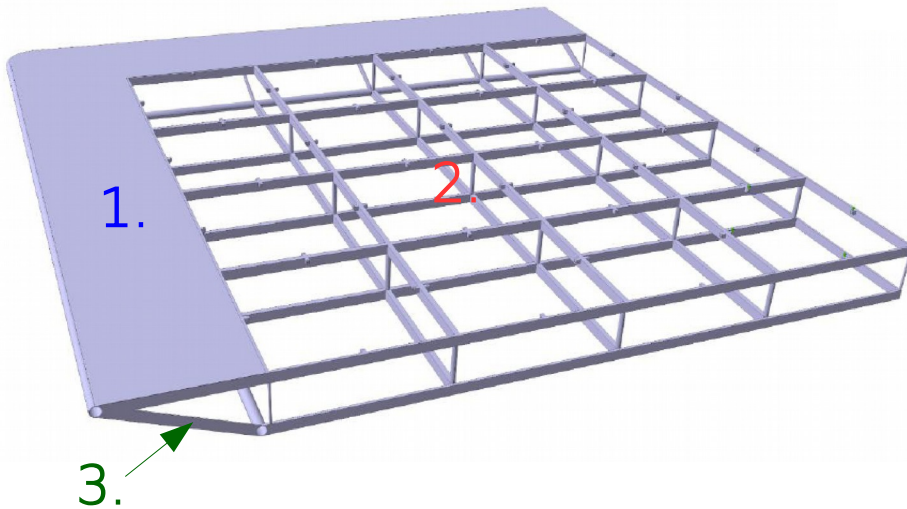
WA105 SB Meeting

12 October 2016



Cathode supporting structure implementation

Drawing of $\frac{1}{4}$ of the supporting structure



Reflectivity of the structure:

- Set to **0%** for scintillation photons
- Varied from **0% to 100%** for shifted photons

Structure implemented in LightSim:

1. 515mm stainless steel frames (thickness of 40mm)
NEW : photons are not automatically killed as before
2. "Middle" structure composed of rectangular tubes (40x20x10mm)
3. "Angular" tubes are **not** implemented for the time being

Procedure to study this impact

- Simulation of $N=10^6$ photons at different positions in the detector.
- These production points cover $\frac{1}{4}$ of the detector in X-Y

$$\begin{aligned} -3000\text{mm} < (X \text{ and } Y) < 0\text{mm} \\ 0 < \text{Distance to the cathode} < \sim 6\text{m} \end{aligned}$$

- For each position :

- Computation of the **weight** :
$$\text{weight} = \frac{\text{Number of photons hitting the PMTs}}{\text{Number of generated photons}}$$
- Computation of the ratio between the two configurations :
$$\frac{N_{65\text{cm}}}{N_{1\text{m}}}$$
- Computation of the ratio
$$\frac{N_{Struct}}{N_{NoStruct}}$$
 between the results before and after the structure implementation.

Reminder :

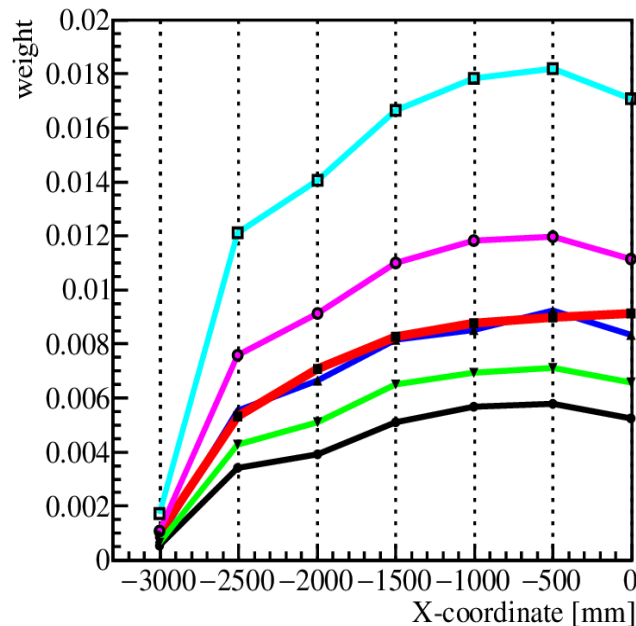
- Labs= ∞
- What is called “reflectivity” in the next slides : only for **shifted** photons.
- We look at the total amount of light collected by the PMT array = **Sum of 36 PMTs**

Impact of the cathode supporting structure on light signal

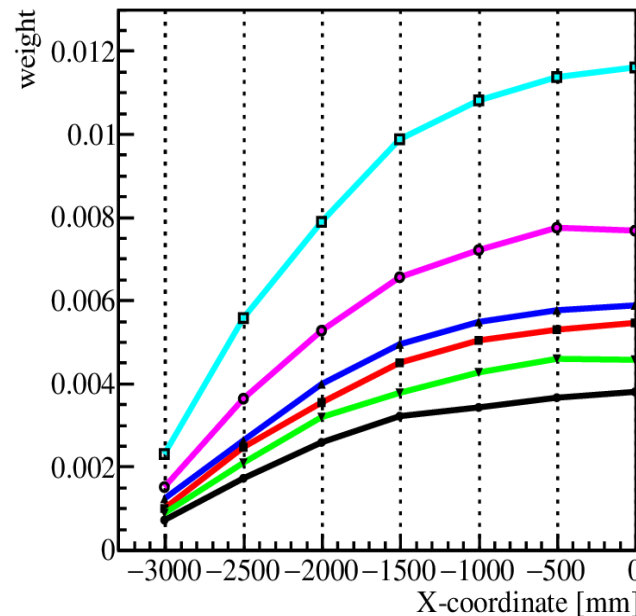
Configuration 1 : PMT every 1m²

Dependence to X-coordinate (center of the tank : (X,Y)=(0,0))

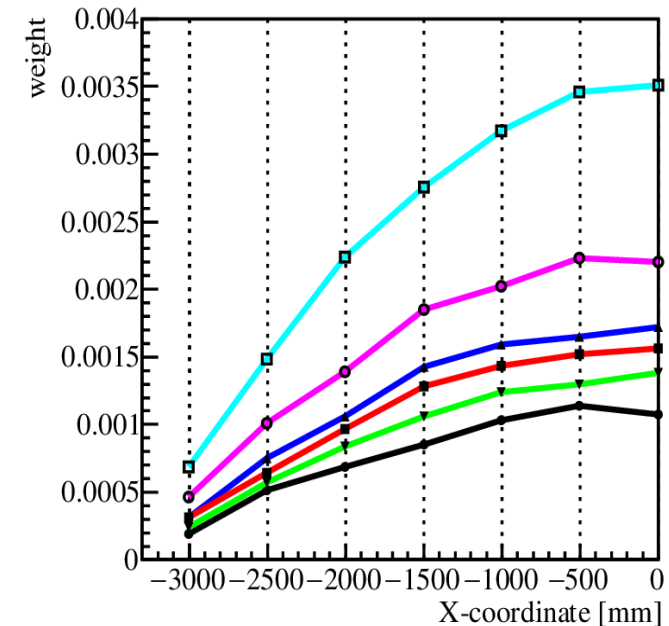
55mm
from the cathode



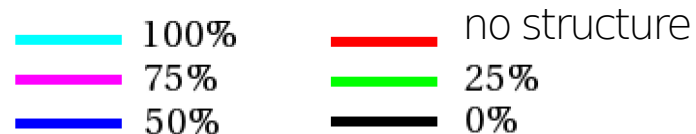
1055mm
from the cathode



3055mm
from the cathode



Reflectivity of the structure

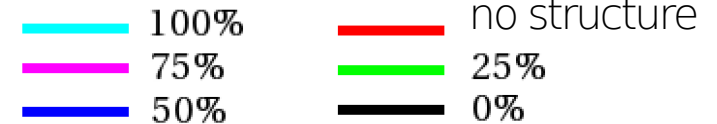


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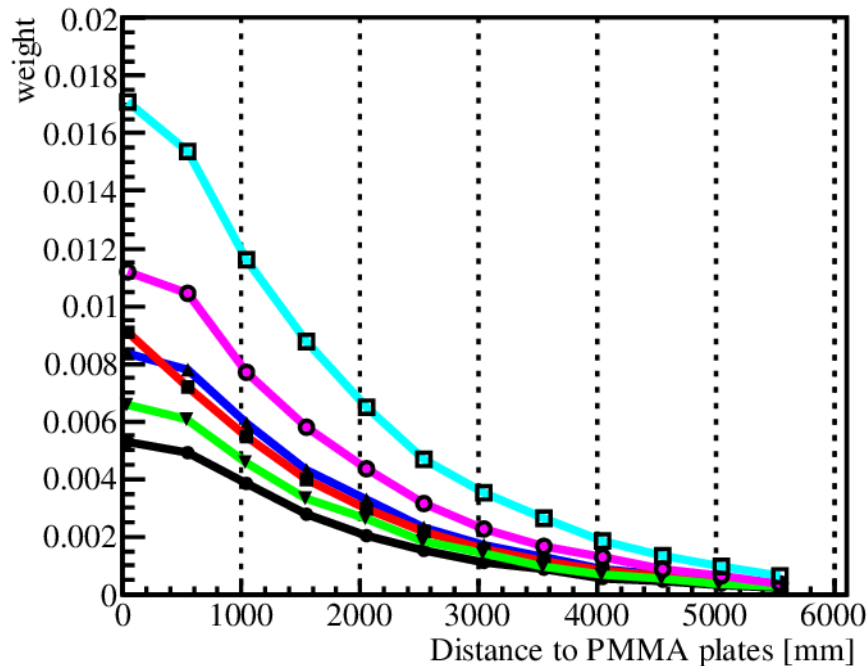
Configuration 1 : PMT every 1m²

Dependence to the distance to the cathode plate
= Z position of the production point.

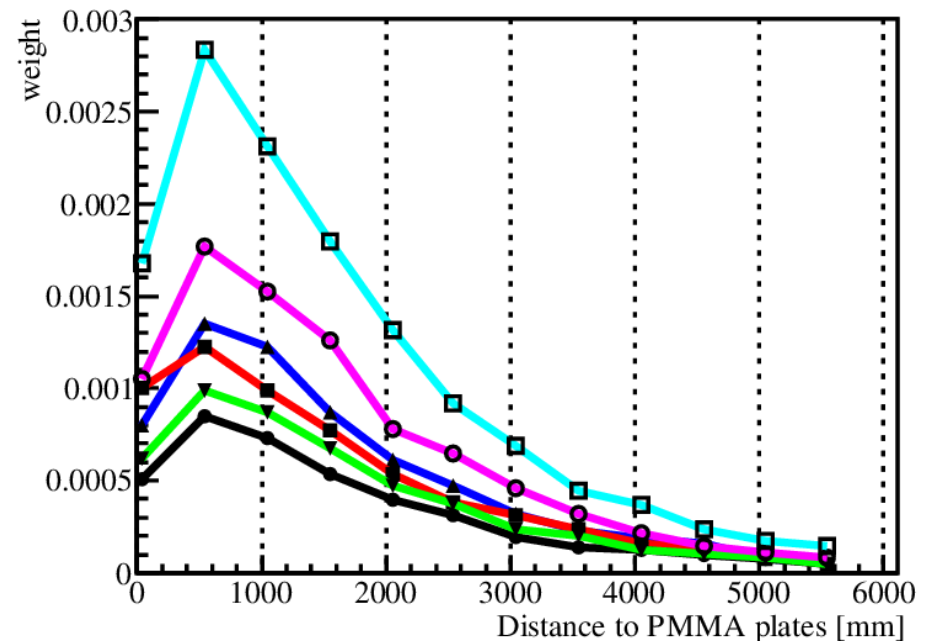
Reflectivity of the structure



X=Y=0
(center of the tank)

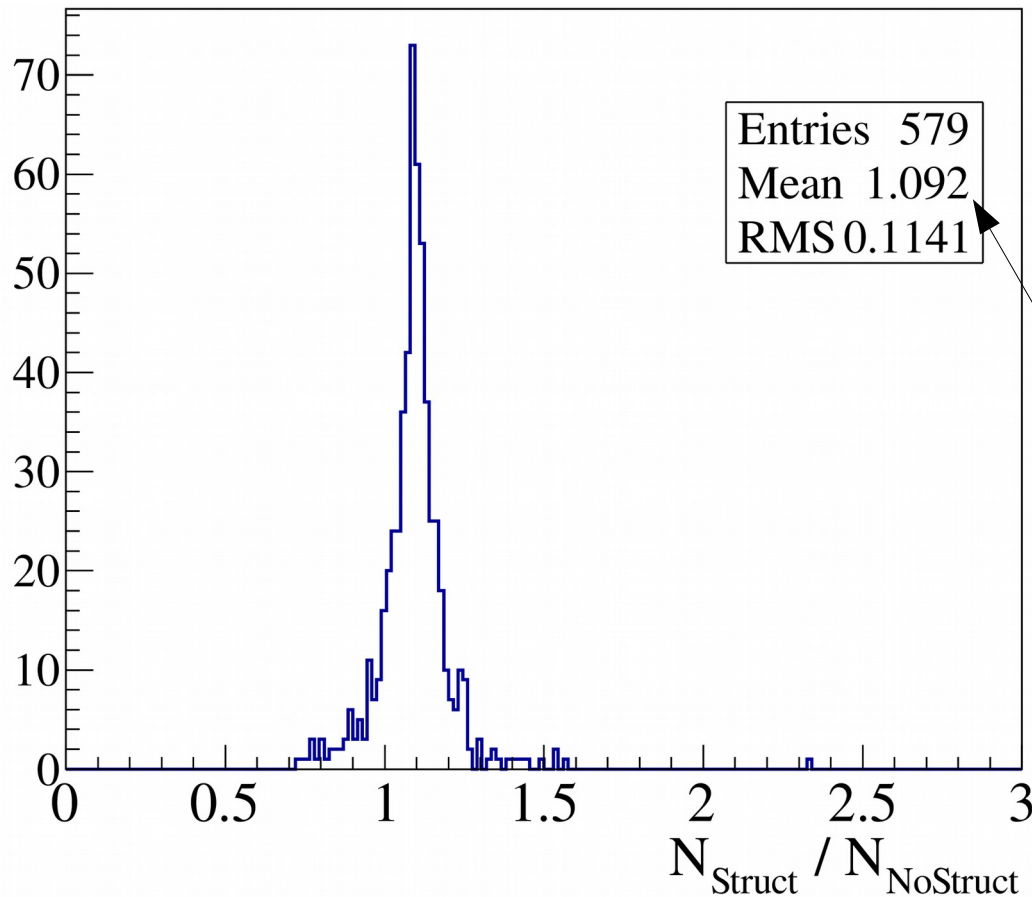


X=-3000mm and Y=0
(close to the field cage)



Impact of the cathode supporting structure on light signal

Configuration **1** : PMT every 1m²
Structure Reflectivity : **50%**



Distribution of the ratio $\frac{N_{Struct}}{N_{NoStruct}}$
for ~ 580 different production points
(covering $\frac{1}{4}$ of the detector in X-Y)

Mean ratio of ~ 1.1

The cathode supporting structure reduces the number of collected photons
for $\sim 12\%$ of cases (72 productions point)

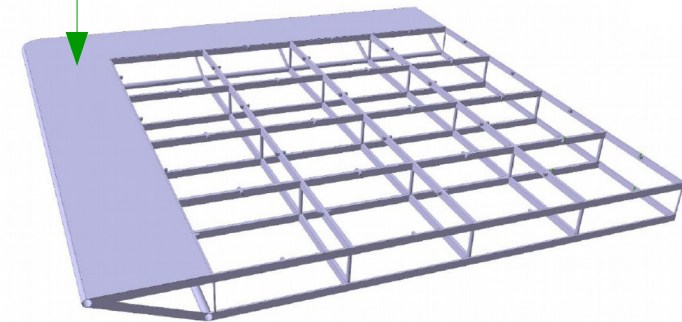
Impact of the cathode supporting structure on light signal

Mean ratio of the 588 different production points

	PMT Configuration	Reflectivity of the cathode supporting structure				
		0%	25%	50%	75%	100%
$\frac{N_{Struct}}{N_{NoStruct}}$	1m-spaced	0.70	0.86	1.09	1.39 1.46	1.91 2.23
	65cm-spaced	0.70	0.85	1.04	1.31 1.34	1.73 1.87

- The **cathode supporting** structure:
 - **Decreases** the number of collected photons for reflectivities **below** 50% (decrease of 30% for a total absorption)
 - **Increases** the number of collected photons for reflectivities **greater** than 50%.
- The effect of the supporting structure is similar for **both** PMT configurations

Effect of the reflection on
"border" structure:
change only for
reflectivity > 50%



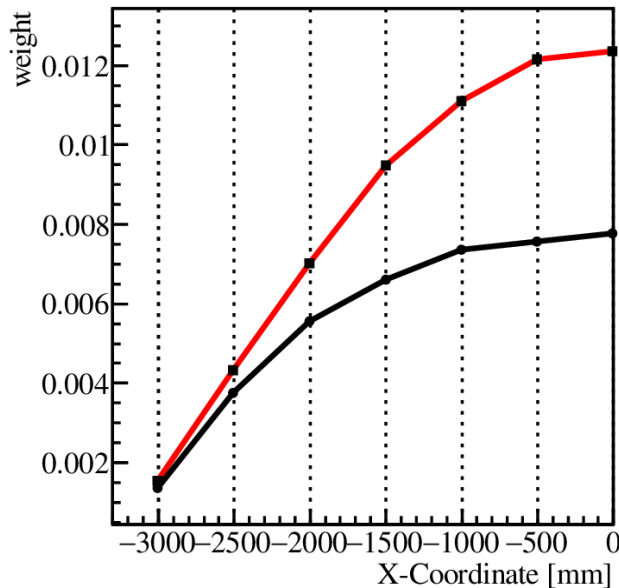
Impact of the PMT configuration on light signal with the cathode supporting structure

Comparison after the cathode supporting structure implementation
(with cathode reflectivity = 50%)

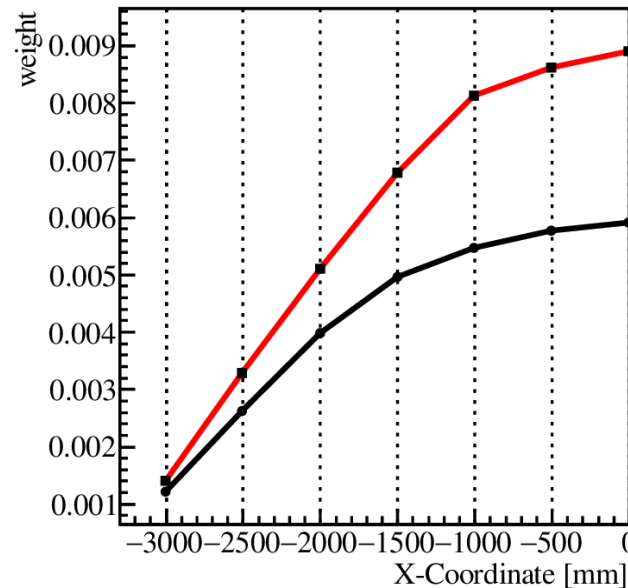
Dependence to **X-coordinate** (center of the tank : (X,Y)=(0,0))

— PMT spaced by **1m²**
— PMT spaced by **65cm²**

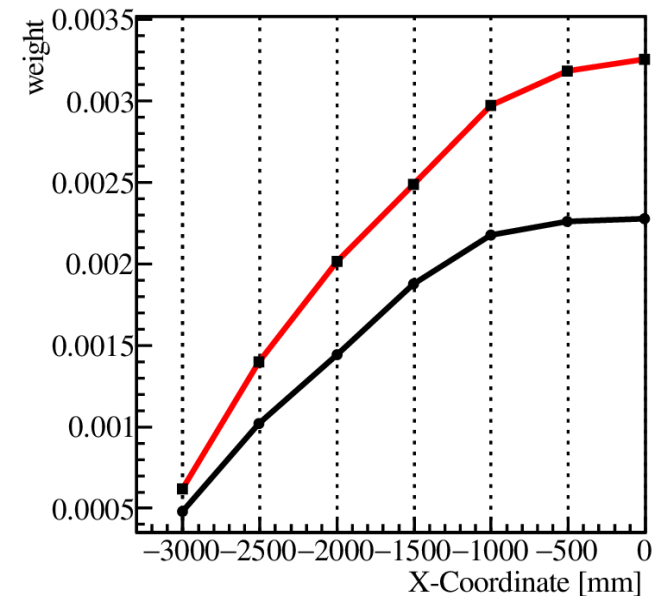
555mm
from the cathode



1055mm
from the cathode



2555mm
from the cathode



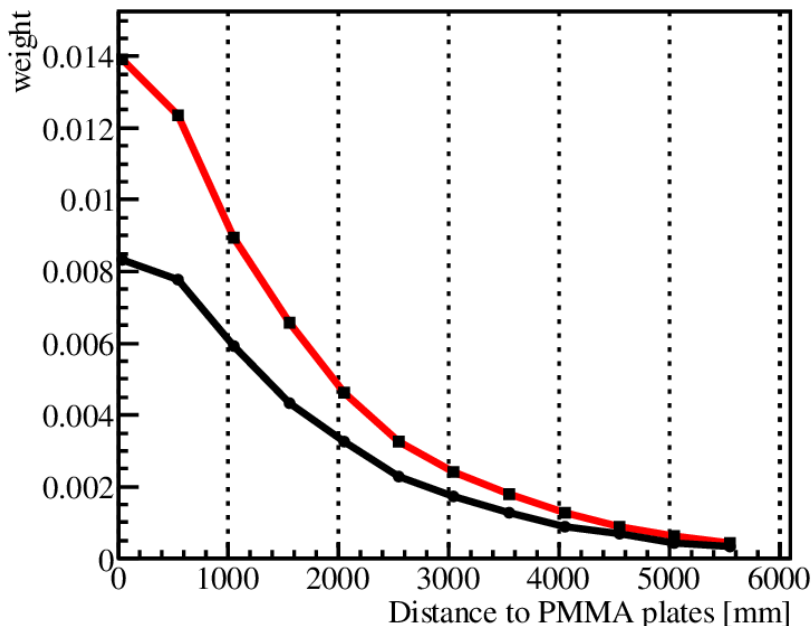
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Comparison after the cathode supporting structure implementation
(with cathode reflectivity = 50%)

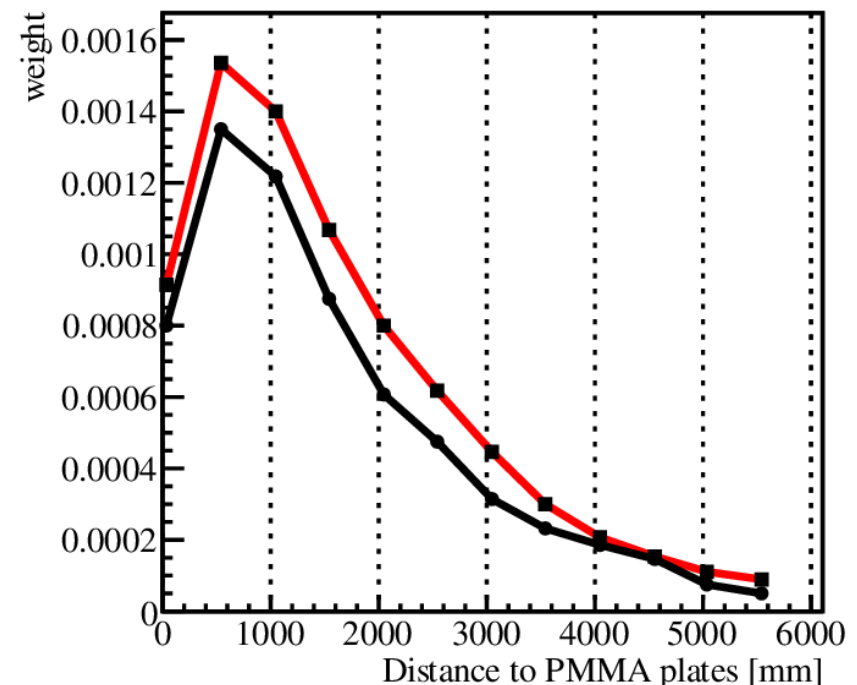
Dependence to the distance to the cathode plate
= Z position of the production point.

— PMT spaced by 1m^2
— PMT spaced by 65cm^2

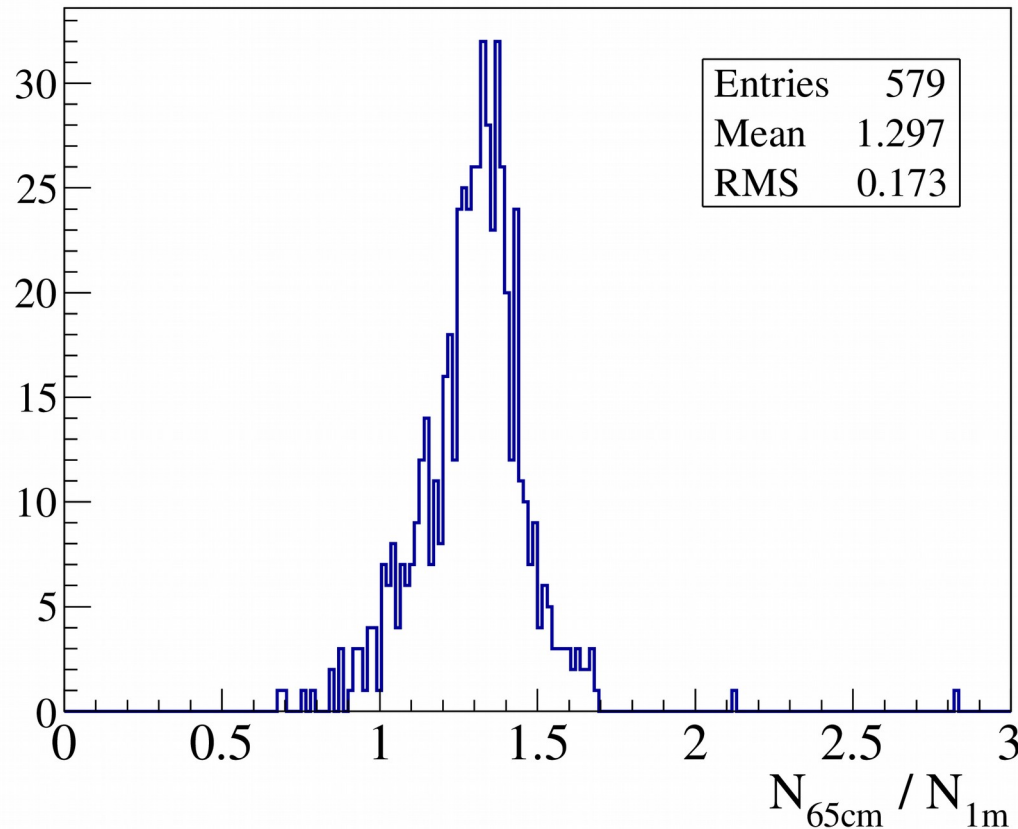
$X=Y=0$
(center of the tank)



$X=-3000\text{mm}$ and $Y=0$
(close to the field cage)



Impact of the PMT configuration on light signal with the cathode supporting structure



Distribution of the ratio $\frac{N_{65cm}}{N_{1m}}$
for ~580 different production points
(covering $\frac{1}{4}$ of the detector in X-Y)

Structure Reflectivity : 50%

- In **most cases**, the 2nd option (PMTs spaced by 65cm²) **increases** the number of photons reaching the PMT array.
 - Mean ratio $\frac{N_{65cm}}{N_{1m}} = 1,30$
 - It reduces the number of photons for **4,5%** of cases (26 production points)

Impact of the PMT configuration on light signal with the cathode supporting structure

Gain improvement going from 1m to 65cm spacing

Mean ratio of the 588 different production points

	Reflectivity of the cathode supporting structure				
	0%	25%	50%	75%	100%
$\frac{N_{65cm}}{N_{1m}}$	1.39	1.35	1.30	1.24	1.14

→ For all reflectivities, the configuration 2 (**PMT spaced by 65cm**) globally **increases** the number of collected photons.

→ It decreases the number of photons only when produced **near** the field cage.

Summary

- The **cathode supporting** structure:
 - **Decreases** the number of collected photons for reflectivities **below** 50% (decrease of 30% for a total absorption)
 - **Increases** the number of collected photons for reflectivities **greater** than 50%.
 - The effect of the supporting structure is similar for **both** PMT configurations
- The value of the cathode supporting structure **reflectivity** is important for the light maps simulation.
- The configuration 2 (**PMT spaced by 65cm**) globally **increases** the number of collected photons independently of the cathode supporting structure reflectivity.